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**REMARKS**

In response to the Patent Office Letter of January 9, 2008, the Applicant respectfully requests re-examination and reconsideration. To further the prosecution of this application, claims 1 and 9-12 have been canceled from the application and a new independent claim, namely claim 13 has now been introduced in its place.

In paragraph 1 of the Patent Office Letter, the Examiner has objected to the drawings as not including the subject matter of claims 9-11. Claims 9-11 have now been canceled from the application and thus this should overcome this objection.

In paragraph 2 of the Patent Office Letter, claims 4 and 5 have been objected to. Amendments have now been made in both of those claims and thus any objections should now be overcome.

In paragraphs 3-6 of the Patent Office Letter, the Examiner has rejected claims 10 and 11. Again, in view of the cancellation of these claims, this rejection is now overcome.

In paragraphs 7-20 of the Patent Office Letter, the Examiner has set forth a rejection under both 35 U.S.C. §102 and 35 U.S.C. §103 relying primarily upon the Oba et al. U.S. Patent 5,262,586, hereinafter referred to as the '586 patent. In addition, the Examiner has also relied in connection with some of the dependent claims on Nozaki et al., U.S. Patent No. 5,247,129, hereinafter referred to as the '129 patent and Carter, Jr., U.S. Patent No. 6,700,047, hereinafter referred to as the '047 patent. Lastly, a rejection of claim 9 relies upon the Ishimura et al. U.S. Patent No. 5,581,623, hereinafter referred to as the '623 patent.

Before discussing the references cited by the Examiner in detail, the Applicant wishes to point out important aspects of the system of the present invention. In this regard, one of the important aspects of the present invention is the realization that fragments of harmonics of the spectrum of each tone are accounted for which is not the case with the prior art documents. The basic idea of the system of the present invention is related to influence, shape and form that the piano tone represents by modifying the normal output from the vibrating sound board. This is characterized, in accordance with the present invention, by injecting additional vibrating energy

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into the sound board based on individual fragments of each harmonic of the spectrum of each tone or any combination of the harmonics of the vibrating spectrum of one tone or any plurality of tones. During the injection into the vibrating sound board, the energy of the selected fragments of the harmonics of each tone mix with the vibrating sound board excitation, particularly vibrations of the sound board generated by the vibrating strings. This technique therefore keeps the natural and traditional base of the acoustic sound pattern of the acoustic piano with it being assisted acoustically by the additional energy injected into the vibrating sound board.

In accordance with the present invention the sensors that are used do not sense vibrations directly from the sound board but instead measure only the movements of the key actuation. The fragments of harmonics are stored.

Fragments of harmonics of the spectrum of a tone can be described as follows. It is known that each individually acoustically produced single piano tone represents a wave pattern producing a spectrum of harmonics (Fig. 1). It is also known that each string of each tone vibrates in different intensity depending on the force of the hammer that hits the string, on the hardness of the hammer felt, on the shape of the hammer head, to just name a few reasons for differences in the building of the harmony spectrum (spectrum of over tone or partials) of an acoustically generated piano tone. The complexity of an acoustically generated piano tone is therefore determined by the natural spectrum of harmonics the strings generate and the sound board amplifies depending on the behavior of the string vibrations during the course of the tone building fragments (Fig. 2, B) immediately after the hammer attack (Fig. 2, A) until the course of the tone building fragment reaches this peak (Fig. 2, B) and thereafter followed by the course of the tone decay fragment (Fig. 2, D) which starts after the course of the tone building fragment has reached its peak (Fig. 2, C) until the course of the tone decay fragment ends (Fig. 2, E).

Injecting selected fragments of the harmonics of the spectrum of a piano tone only by feeding additional vibrating energy into a vibrating sound board in the sense of our application is totally different from all other approaches to influence piano tone as described in the patents

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'586, '047 and '129 considered by the Examiner and as known to any person of ordinary skill in the technology of generating and influencing piano tone by means of assisting a sound board in its vibration behavior. The energy of the selected fragments of the harmonics of each tone additionally fed into the vibrating sound board are mixed with corresponding vibrations of the sound board generated by the vibrating strings. This keeps the natural and traditional base of the acoustic sound pattern of the acoustic piano just being assisted in his acoustically produced sound pattern by the additional energy injected into the vibrating sound board while this assisting effect allows the shaping and changing of the tone character.

Figs. 4-11 (explanation see below) represent basic ideas used for the invention. For any selected individual harmonic or any combination of the spectrum of the harmonics of each single tone the tone building fragment(s) (Fig. 2, B) or the decay fragments (Fig. 2, D) or any combination thereof can be influenced by injecting the related vibrating energy into the vibrating sound board of a stringed acoustical piano.

Under the assumption of for example 8 harmonics per tone and three assumed fragments per tone, the invention allows to influence 586 different parameters ( $8^2 \times 3^2$ ) of each single tone and in consequence to influence also any plurality of the up to 88 tone of a stringed acoustic piano offering an up to now unknown variety of influencing each single tone and in consequence thereof also the complex tone patterns becoming audible by means of the vibrating sound board of a stringed piano now allowing to change, shape, and voice by electronical means the sound patterns of an acoustic piano in addition the known handcrafted means on making changes to the hammerheads of the acoustic piano.

The following provides further comments regarding the objections of the Examiner.

Below are discussed the differences between the '586 patent and the present invention.

U.S. Patent No. 5,262,586 teaches

- the known technology of acoustic pianos with key actions and sound boards.

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• the fact that sensors detect the complex vibrations from the sound board or other panels of the instrument. These vibrations represent the complete sound pattern as amplified by the sound board.

• that such complex vibrations are processed and re-injected into the sound board.  
• that re-injection is done by means of actuator or driver device which is a known technology.

• the re-injection of energy into the vibrating sound board is limited (closed-loop system).

The present invention

• represents the known technology of acoustic piano with keys/actions and sound boards.  
• does not detect any vibrations from the sound board or other panels of the piano.  
• does not process any sound patterns produced by the instrument for re-injection purpose.

• processes key actuation signals directly from the sensor that couple directly from the key actuation.

• uses the injection of vibrating energy into a vibrating sound boards by means of actuators or drivers which is a known technology.

• the re-injection of energy into the vibrating sound board is not limited (open-loop system).

All the inputs in the '586 patent are provided from vibrating means: strings, sound board, lid, and so on, and are revealed by vibration transducers (pickups or microphones). As we will show, this closed loop system makes a substantial difference in principle and in behavior.

The present invention is an open loop system, as we only read the key actuation from the key sensors while the energy put into the sound board are not complete tones or processed alternatives of complete tones as in '586 but individually for each tone selected and controlled partials or fragments thereof of said tone. This means that the amount of energy which can be added to the piano by the present invention is limited only by structure integrity and sound likeliness. The system depicted by the U.S. '586 patent is a closed loop system, in which the

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input information about sound/vibration is taken from the vibrating means (sound board, etc.) itself, and is re-injected, after processing, again into the vibrating means. In such a system there is a theoretical and practical limit, which limits the gain of the loop. In fact if the retroaction gain (loop gain) of the whole system is  $> 1$  (in other words, if the volume control of the amplifier is raised enough to be useful), than the system becomes unstable and self-oscillating, thus creating Larsen effect, exactly like a microphone and a loudspeaker very near to each other, connected by an amplifier. In fact, this will limit the additional energy that can be injected into the sound board by the '586 patent.

The present invention on the other hand can work on each individual note, thus allowing precise equalization of sound character through the whole extension of the keyboard (which is an important point in quality acoustical pianos, and until today is achieved through handcrafted voicing, which is a time consuming operation which can be done only by highly skilled technicians), allowing control of the characteristic of each single note in a piano, depending on how the pianist solicits that note. However, this voicing or needling the hammer felt is limited to the point where the hammer felt does not react anymore and cannot be frequently repeated, as the electronic voicing and change of tone character allows under the new invention described. The '586 patent works (if it can ever work) on a more general range, detecting the vibration of the sound board which is in its entirety the product of a very complex interaction pattern between the vibrating strings of playing notes and all the other vibrating means. Once the vibration flows from the string to the sound board, the possibility of a selective control on it is lost, as it cannot be discriminated from another. In the diagrams shown in the '586 patent there is no chance that the computing system can reveal which note has been played, how, and consequently react. The problem of selectively discerning notes in a complex sound is still unresolved. This introduces reasonable doubts about the claimed naturalness of the produced sound. Example: let's suppose that in order to equalize a certain note we want to increase the acoustical level of its 2<sup>nd</sup> harmonic, which lays, let's say, at 500 Hz. The present invention allows us to increase only the 500 Hz vibration of that specific note, while the '586 patent will

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increase all vibrations at 500 Hz, being unaware of which note/key is being played. So with the '586 arrangement, it will affect the global frequency response of the whole instrument in the region of 500 Hz, not specifically changing the sound pattern of the given note but negatively affecting every other note which produces a harmonic in the 500 Hz range.

The present invention allows us to change selectively the harmonic content of every single note and in addition also the tone building process increases the aggressive character of the tones or the tone decay process extending the decay period and making the tone much longer or increasing the tone preposition making the piano more powerful. Through a precise and harmonic-selective modification, on a note per note basis, it is possible to affect the sound character of the piano, thus simulating on a single instrument a wider range of pianos. This also means that an instrument can be adopted by electronic means to individual room acoustics which may require adjustments in some parts or throughout the complete range of the 88 notes. The present invention is immune to environmental noises (like an orchestra playing together with the piano) as it cannot capture them, as there are no microphones, nor pickups, to capture vibrations. The '586 patent will reproduce external noises/sounds, as the vibrating means connected to vibrations detectors will capture all kinds of air vibration, and will affect the control signal fed into the vibrating means.

Example: a piano is equipped with the '586 patent and a player plays it together with an orchestra: from the sound board and other vibrating means will come out, not only the modified piano sound, but also an altered orchestra's sound, which is obviously an unwanted side effect of the '586 patent.

The '586 patent teaches a sound controller and other processing means which are intended to control "sound patterns" as received from the sound board or other vibrating panels being thereafter processed. The present invention represents by no means (also not for a skilled person in the art of such technology) any of the tone technology used and described in the '586 patent. The present invention represents the memorizing of "tone building fragments" and "tone decay fragments" of individual harmonics of the spectrum of each tone which according to the

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invention can individually or in any plurality be addressed in the memory, amplified and by means of actuators or drivers is additionally injected into the vibrating sound board where this energy specifically assists the sound board in vibrating while generating the audible sound pattern. The present invention represents a controlling device, which allows addressing the individual harmonics of the spectrum of each individual tone. This is basically different from what the control device in the '586 patent is intended for. The present invention delivers to the sound board individual fragments of the harmonics of the tone spectrum as may be selected, tone by tone, by means of said controller. Those fragments of the harmonics of the spectrum of each tone are taken from a memory device.

U.S. Patent 6,700,047 describes the use of a second tone amplification device (loudspeaker) making audible such tones coming from an electronic sound source or memory or processor in order that such sound becoming audible through the loudspeaker may compliment and improve such tones acoustically generated tones as they are played on the piano while then both sound amplification devices work separately and the music waves mix in the air.

In contrast, the present invention represents the memorizing of fragments of each harmonic of the spectrum of each tone, which after amplification as additional vibrating energy, can be injected into the vibrating sound board assisting its vibration pattern within the limits of the selected fragments of the harmonics of the tone.

The present invention is in no way intended to change a poor piano sound into a good piano sound which does not work anyway, because the mixing of two different qualities of sound patterns in the air does not change the quality of the sound pattern originating from the vibrating strings and made audible by the vibrating sound board.

With regard to U.S. Patent 5,247,129, this teaches a kind of a piano with a sound board panel and a known system of action and keys but does not incorporate any strings. The '129 patent uses the tone samples for generating the sound while the present invention uses the strings for generating the sound and a sound augmenting device intended for memorizing fragments of harmonics of the spectrum of each tone, which after amplification as additional vibration energy,

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can be injected into the vibrating sound board assisting its vibration pattern driven by vibrating strings within the limits of the selected fragments of the harmonics of the tone.

To summarize, the '586 patent does not teach any control of individual tone or tone shaping. The '586 patent simply teaches a control arrangement in which vibrating energy is received from the sound board or from other vibrating panels and not a tone sample monitoring device delivering only partials of each tone or even fragments thereof, so that in accordance with the present invention, the tone building and tone decay of each harmonic of each tone can be individually addressed and mixed by the control and processor in order to shape, form and electronically "voice" each individual tone. The present invention does not detect any vibration of the piano that is being played but uses the information received from key or action sensors in order to address a memory device containing each of the individual tone building and tone decay segments. Stated in another way, the present invention does not detect vibrations from the sound board as in the '586 patent but instead relies upon stored information representing individual tone building and tone decay fragments.

Now, in order to make this distinction clear, and with particular reference to the '586 patent, a new main claim 13 has been structured to indicate that the controller receives the sensor data signal in order to control the drive means. Claim 13 defines a sensor associated with each action for detecting actuation of only the associated key and for recording corresponding movement of the key in order to specify the key played. As indicated previously, claim 13 then defines the controller as receiving the sensor data signal to, in turn, control the drive means. The drive means is for delivering additional vibration energy to the sound board. Claim 13 also defines the controller as including a sound-augmenting device to which the measured signals of the sensors are supplied in order to know what keys are played and with this device addressing the corresponding tone sample in the memory in order to select from there the partials of fragments for each selected tone. With the inclusion now of claim 13, it is believed that this claim clearly patentably distinguishes over the prior art, and in particular the '586 patent. The other references that have been cited by the Examiner have also been considered but in view of

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the structure of the new claim 13, it is believed that these other references are no longer pertinent whether they be taken alone or in combination with the '586 patent.

The Applicant has also added additional claims 14-18 to this application. These are all dependent claims. For example, claim 14 defines the sound augmenting device as including a tone control device and a tone sample memory with the tone control device receiving and defining the key played in order to select the corresponding tone sample memory of which selected and controlled partials or fragments, and wherein the tone sample memory output of the partials of the selected tone are processed in real time. These limitations as found in claim 14 are not obvious in view of the '586 patent whether it be taken alone or in combination with other patents cited by the Examiner. In this regard the Examiner has referred to the '129 and '047 patents for teaching of sampling. However, these patents do not teach the combination of claim 14 including a tone control device and a tone sample memory with the tone control device essentially processing signals from the sample memory not representing complete tones but only selected and controlled partial and fragments thereof in any desired combination. In addition, even further distinguishing subject matter is found in claims 15-18.

The Applicant also submits herewith additional claims 19 and 20. Claim 19 is an independent claim and claim 20 depends from claim 19. Claim 19 also recites the important distinguishing feature of the present invention in which the sensor data from the keys are used to address the corresponding tone sample that is memorized in the memory unit. Accordingly, it is noted that claim 19 recites a tone modification device that combines the information of the mechanically actuated keys with the corresponding memorized range of overtones belonging to the tone actuated by actuation of a key. The added claim 19 also recites the control module that teaches the tone modification device to be selected and combined in order to be delivered in real time to the vibrating sound board. Finally, an amplifier is defined for amplifying signals received from the tone modification device in order to deliver the amplified signals through driver means to the vibrating sound board. These limitations found in claim 19 should clearly describe a patentable distinction over the prior art cited and relied upon by the Examiner. In addition, claim

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20 has been added to the application and further recites the tone modification device as including a tone control device and a tone sample memory with the tone control device receiving key actuation signals from the sensors and combining this data signal in order to select data from the tone sample memory. Again, this further limitation of claim 20 is not taught by the prior art relied upon by the Examiner.

To further illustrate the principles of the present invention the Applicant also attaches herewith a Comparative Table. In this table the left-hand column represents the various topics or aspects of importance. The middle column refers to the present invention and the right-hand column refers to the prior art.

### **CONCLUSION**

In view of the foregoing amendments and remarks, the Applicants respectfully submit that all of the claims pending in the above-identified application are in condition for allowance, and a notice to that effect is earnestly solicited.

If the present application is found by the Examiner not to be in condition for allowance, then the Applicants hereby request a telephone or personal interview to facilitate the resolution of any remaining matters. Applicants' attorney may be contacted by telephone at the number indicated below to schedule such an interview.

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The U.S. Patent and Trademark Office is authorized to charge any additional fees incurred as a result of the filing hereof to our Deposit Account No. 19-0120.

Respectfully submitted,  
Roberto VALLI et al., Applicants

Dated:

7/9/08

By:

  
\_\_\_\_\_  
David M. Driscoll, Reg. No. 25,075

Applicant's Attorney  
SALTER & MICHAELSON  
321 South Main Street  
Providence, Rhode Island 02903  
Telephone: 401/421-3141  
Facsimile : 401/861-1953  
Customer No. 000987

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## Comparative Table

### Shaping the tone character by feeding selected harmonics or fragments thereof as additional vibration energy to the soundboard (called electronic voicing)

<b>The general principle of electronic Voicing</b>	Possible (absolutely new)	Not possible	Has not been thought of nor mentioned
<b>Electronic voicing is done tone by tone</b>	YES	Not possible	Only traditional needling of hammers
<b>Electronic voicing a specific tone allows to work with its individual harmonics with the tone building fragment of each of the individual harmonics with the tone decay fragment of each of the individual harmonics</b>	YES With no limits to what harmonic YES Shaping the tone building process YES allowing to extend tone duration	Not possible Not possible Not possible	Also very limited with traditional hammer needling Also very limited with traditional hammer needling Also not possible with traditional hammer needling

### Possibility to individually adjust the tone character of the instrument in sections or over the compass of the instrument by electronic voicing

To specific room acoustics	Yes	No	No
To specific requests of the pianist	YES	NO	NO
To specific musical literature	Yes	NO	NO

### Possibility to instantly change the tone character of the instrument in sections or over the compass of the instrument by external controls (instant electronic voicing)

At any time during a concert (for different music literature)	YES	NO	NO
Within the same music piece while playing	YES	NO	NO

### Larsen effect and external noise immunity

Limitations of possibility to feed additional vibration energy to the soundboard	By the structure of the instrument	By the Larssen effect if amount of energy injected becomes too big
Noise immunity	None	YES - if external noise influences the panels used as tone source

### Principle of using tone sample stored in the memory device

The memorised harmonics and their fragments are individually used	YES	NO	Not in 586 nor in the other patents mentioned
The complex tone structure with their sampled spectrum of harmonics is used	NO	YES	In 586 the tone source are the signals taken from the instrument In the other patents mentioned the complete samples are used